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ABSTRACT

This paper presents an alternative, nonlinear view of technology adoption among teachers participating in The WEB Project, a Technology Innovation Challenge Grant. It is based on a number of new theories, including activity and systems theory, and upon previous evaluations of large scale educational technology programs by RMC Research Corporation, notably the Boulder Valley Internet Project. The paper presents the Integrated Technology Adoption and Diffusion Model, describing a learning/adoption trajectory, i.e., a cyclical process in which teachers evolve from learners (teacher-trainees), to adopters of educational technology, to co-learners/co-explorers with their students in the classroom, and, finally, to a reaffirmation/refection decision. The evolution of the model to include a fifth stage, i.e., teacher as leader, is described. (Contains 14 references.) (MES)

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NEW INSIGHTS ON TECHNOLOGY ADOPTION IN COMMUNITIES OF LEARNERS

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Abstract: This paper presents an alternative, nonlinear view of technology adoption among teachers participating in The WEB Project, a Technology Innovation Challenge Grant. It is based on a number of new theories including Activity and Systems Theory, and upon previous evaluations of large scale educational technology programs by RMC Research Corporation, notably the Boulder Valley Internet Project.

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With the current emphasis on presentation, communication, and WEB technologies in all settings--K-12, higher education, corporate training, and online learning networks--effective design of learning environments is a large concern. However, the adoption, implementation, institutionalization, and other aspects of technology are often given less emphasis than they deserve.

We know that the Internet affects student learning, but the research is still ongoing about how members of learning communities adopt technology and telecommunications and use them to enrich teaching and learning. As we studied the formation of online communities of learners and the integration of technology in middle and high schools in the state of Vermont, we found that Rogers' (1995) *Diffusion of Innovations* framework and Hall and Hord's (1987) *Concerns-Based Adoption Model* (CBAM) did not adequately describe the systemic process in which technological, individual, organizational, and pedagogical factors interact throughout the life span of an instructional technology program. However, these models form the conceptual framework for many new studies of innovations, such as Dooley's holistic framework for the diffusion of educational technologies (Dooley 1999).

Our purpose in this paper is to explore an alternative view based on a number of new theories, including activity and systems theory. We then present a dynamic model based on a case study of The WEB Project, a Technology Innovation Challenge Grant that is entering its fifth and final year of implementation.

Background

In 1962, Everett Rogers published the first edition of *Diffusion of Innovations*. In this seminal work, an innovation was conceived of as an *object* with five perceived attributes--relative advantage, compatibility, complexity, trialability, and observability--that help one to explain its rate of adoption. The decision by a user to adopt or reject the innovation is an *event*--a point in a linear process--with time as an independent variable. The process of adoption consists of a series of actions and choices over time, based on internal factors within a social system. Rogers' diffusion studies addressed innovations such as new types of grain, water purification systems, and birth control clinics in underdeveloped countries.

Change in Schools (Hall & Hord 1987), based on the pioneering work of Frances Fuller, brought about a psychological shift from properties of an innovation to the concerns of its users. It also refocused the role of a change agent from a promoter to a facilitator. In the Concerns Based Adoption Model (CBAM) of Hall and Hord, users pass from self concerns, through task concerns, to impact concerns as they become more experienced with the use of the innovation. Like *Diffusion of Innovations*, the CBAM model is also linear in nature.

As we applied these models to the adoption and diffusion of technology into classrooms in Vermont, we found that they did not fit well. Innovations such as the Internet, the WWW, and online learning

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technologies are not static (Batty et al. 1999). In fact, they evolve faster than traditional research studies can deal with them. Moreover, the first stage of adoption is gaining knowledge about the innovation. For interactive technologies, this is a continuous learning process for all users, be they novices or experts.

Having observed teachers and students in The WEB Project cooperating schools for the past three years, we found that the adoption, implementation, and institutionalization process of technology-based active learning in the arts, social sciences, language arts, and humanities, is simply not linear. Teachers are co-learners and co-explorers with their technologically-savvy students. The community of learners, supported by The WEB Project's electronic network, evolves in expertise in a dynamic, systemic fashion as the technology acts as a "carrier of practices" for all of its members.

As a result, we need to look for alternative views that can explain:

- The explosive growth of the Internet and the learning communities that it supports;
- The realities of federally funded instructional technology programs;
- Multiple levels of scale, both individual and group;
- The use of interactive learning tools in an intentional context; and
- The cyclical nature of the change process.

Developing An Integrated Technology Adoption and Diffusion Model

Through our evaluations of several educational technology initiatives, especially the Boulder Valley Internet Project (Sherry, Lawyer-Brook, & Black 1997; Sherry 1997), we found that teachers generally go through four distinct stages as they develop expertise with the Internet and the World Wide Web. Our *Integrated Technology Adoption and Diffusion Model* (Sherry 1998; Sherry 1999) describes a learning/adoption trajectory -- i.e., a cyclical process in which teachers evolve from learners (teacher-trainees) to adopters of educational technology, to co-learners/co-explorers with their students in the classroom, and finally, to a reaffirmation/rejection decision. It is at this fourth stage that teachers decide whether the use of telecommunications to enhance teaching and learning is working for them; contributing to their self-efficacy as teachers; compatible with their personal vision of learning; and worth the time and effort that they have put into mastering a new set of skills. The Learning/Adoption Trajectory is presented in Figure 1.

Figure 1: The Learning/Adoption Trajectory (Adapted from Sherry 1999)

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In this research-based model, the reaffirmers go on to build capacity within their school and among their fellow teachers as they assist their colleagues with troubleshooting equipment, give inservice sessions at their schools, serve on technology planning committees, and become the new round of peer trainers and change agents for their colleagues. If they move to another school, they continue operating at this level, thereby adding a portability dimension to their skills. This is the point that is characterized by Rogers (1995) as confirmation-seeking; it is where reinvention of the innovation may take place. Similarly, Hall and Hord (1987) have observed refocusing activities on the part of users as they shift their concerns from task management to the impact of the innovation on all users within the educational system.

At each of these four stages, there are professional development strategies that work. For example, training may be more appropriate once an "advertising campaign" is in place that informs teachers, parents, and administrators about student successes and promising educational practices using technology in the classroom. Learning communities can also be more easily formed at later stages. In addition, many professional development "sessions" are necessarily embedded within the school day since needs may be immediate. Teachers may turn to each other, to students, or to online help for immediate assistance.

Further Evolution of the Technology Adoption Model: The WEB Project

Based on three years of evaluation of The WEB Project (http://www.webproject.org), a Technology Innovation Challenge Grant in Vermont, we found that the learning/adoption trajectory model was validated (Sherry, Billig & Perry 1999). Data for the 1998-99 academic year for The WEB Project were gathered from interviews, focus groups, and classroom observations that took place during site visits to participating schools; surveys of students, teachers, and administrators; participant observations at the *Making Connections Summer Institute* and the *Basin Harbor Retreat* during the summer of 1999; and an analysis of artifacts such as teacher and project publications and compact discs, threaded discussions, and student projects posted on The WEB Exchange, the project's website. A cross-case analysis was performed between participating sites to identify general trends, and data were analyzed to ascertain the early impact of the project as a whole on student performance.

The WEB Project stresses using online conversation for improving student products and performances in the arts and humanities, and engaging in dialogue about works of literature and current events. Along with the student/teacher forums, there are a number of forums that connect participating teachers, mentors, resident artists and musicians, members of participating initiatives such as the MIDI Project, the ARTT Project, and the Vermont Center for the Book, and other experts, in a community of learners. Through these online conversations, teachers shared ideas, common interests and concerns, and strategies for solving complex problems of practice, and they exchanged messages of mutual support for one another. As a result, The WEB Project ecology spanned the classroom, the school, and the community-at-large, rather than being limited to a specific district or set of classrooms.

As instructional technology continues to evolve and to pervade educational institutions, our model, too, is evolving. When trends in the cross-case analysis of The WEB Project were compared with the original model of the Learning/Adoption Trajectory (see Figure 1), it became clear that participants in The WEB Project had progressed beyond *the teacher as co-learner* and *teacher as reaffirmer/rejecter* stages. The traditional role of the teacher was being restructured. Professional networks of participating teachers were expanding, and teachers were sharing their ideas beyond the bounds of their schools and districts. Teachers were creating and sharing standards and rubrics rather than simply following them. At some cooperating schools, teachers began to institute trainer-of-trainers programs at their schools or among their online learning networks, using students and peers as assistants and co-trainers. At another school, the role of a teacher was restructured so that she could serve as a mentor for other teachers across the project.

Thus, in contrast with findings from earlier instructional technology projects, a fifth stage must be added to the model as it applies to The WEB Project: *teacher as leader*. It is at this point that the system really starts to build capacity. Moreover, this is the stage at which the local community expands beyond its initial bounds to encompass a wider community, linked through an electronic learning network to the environment in which it is situated.

The leadership of The WEB Project was facilitative at this stage. They made the critical decision to link this innovation with others taking place within the state, building on successes of existing initiatives like the MIDI Project, the ARTT project, and the Vermont Center for the Book, and leveraging resources of other participating schools and cooperating initiatives. Support from many sources was garnered, not only from the Vermont Department of Education and administrators throughout the state, but also through the community. Practitioners such as artists and musicians were cultivated and provided constructive feedback to students. Communities were involved in technology based projects at many schools. Administrators were kept informed of all progress and requirements for participation.

The project also built on the educational vision for the state as a whole, specifically on the state standards and the Vital Results. The vision for the project was kept in the forefront of all participants' thinking and represented a shared idea of what everyone wanted to accomplish. Communication was regular and effective. The leadership also remained persistent in their efforts despite occasional criticism and difficulties encountered at the cooperating schools.

Interpreting Observed Effects

It is at the *teacher as leader* stage that we must break away from linear models and start looking at more dynamic models such as:

- the "unfreezing-change-freezing" process described by Schein (1996);
- the circular change model of Havelock and Zlotolow (1997);
- the balancing and reinforcing loops described by Senge (1990); and
- the interaction of users, tools, agency, and the community of users described by Engestrom's (1996) Activity Theory framework.

In Schein's (1996) view, from the perspective of the user, members of a learning organization begin to "unfreeze" their perceptions as their experiences with an innovation fail to match their preconceived notions; go through a change and refocusing process; and then "refreeze" their concepts to match their current experiences. The WEB Project, however, never got caught up in this "refreezing" process. Instead, the project co-directors, teachers, mentors, and students all became quite good at soliciting feedback and using it for continuous improvement.

In contrast with Schein's user-centered framework, Havelock and Zlotolow (1997) focus on the role of the change facilitators as they move a system through six stages of planned change, beginning and ending with care and concern for all clients within both the local and larger community. As in Senge's (1990) view of systems theory, Havelock and Zlotolow note that the bigger the change, the bigger the forces acting against it. To counteract this, multiple channels of diffusion are needed, which can carry a shared vision throughout the entire community. This is exactly what was happening with the leadership of The WEB Project.

Engestrom's (1996) Activity Theory integrates the individual users, their intentional uses of the tools of technology, their desired outcomes, and the community of users with its norms, conventions, and social structure into a framework in which a change to any part of this system ripples through the entire system, affecting each and every component and user. In this vein, The WEB Project eliminated nearly all internal boundaries so that communication was seamless; staff and consultants could easily be accessed; and communication flowed regularly and smoothly. Participants collaborated, solved problems jointly, suggested solutions as appropriate, modeled exemplary behavior for their colleagues, and explored the root causes of problems and their contexts before suggesting a solution.

Table 1 presents the developmental stages of the teachers in the five stages of the newly revised learning/adoption trajectory, together with effective strategies for professional development.

Developmental Stage	Effective Strategies
Stage 1. Teacher as Learner. In this information-gathering stage, teachers learn the knowledge and skills necessary for performing instructional tasks using technology.	Time for training; demonstrations of promising practices; ongoing professional development by peers rather than one-shot workshops by outside experts; inservice sessions that stress the alignment of technology with curriculum and standards.
Stage 2. Teacher as Adopter. In this stage, teachers progress through stages of personal and task management concern as they experiment with the technology, begin to try it out in their classrooms, and share their experiences with their peers.	Online resources, helpdesks, and other forms of readily accessible technical support; mechanisms to deal with technical problems as they arise; in-building technical specialists; other technology-savvy teachers who can mentor new users and provide them with care and comfort as well as information; open lab workshops at school sites to solve specific technical problems.
Stage 3. Teacher as Co-Learner. In this stage, teachers focus on developing a clear relationship between technology and the curriculum, rather than concentrating on task management aspects.	Workshops and online resources with strategies for enhancing instruction and integrating technology into the curriculum; collegial sharing of standards integration; exemplary products and assessment ideas; use of students as informal technical assistants.
Stage 4. Teacher as Reaffirmer or Rejecter. In this stage, teachers develop a greater awareness of intermediate learning outcomes and begin to create new ways to observe and assess impact on student products and performances, and to disseminate exemplary student work to a larger audience.	Administrative support; an incentive system that is valued by adopting teachers; awareness of intermediate learning outcomes such as increased time on task, lower absenteeism, greater student engagement, and increased metacognitive skills; evidence of impact on student products and performances; dissemination of exemplary student work.
Stage 5. Teacher as Leader. In this stage, experienced teachers expand their roles to become action researchers who carefully observe their practice, collect data, share the improvements in practice with peers, and teach new members. Their skills become portable.	Incentives for co-teaching onsite workshops; release time and other semi-permanent role changes to allow peer coaching and outside consulting; support from an outside network of teacher-leaders; structured time for leading in-house discussions and workshops; transfer of skills if teacher goes to another school.

Table 1: Effective Strategies for the Five Stages in the Revised Learning/Adoption Trajectory

In The WEB Project, the various strategies listed above served as facilitators for the teachers as they became more familiar and comfortable with the use of technology for teaching and learning. The particular factors that facilitated adoption varied, depending upon the stage of implementation. For example, the types of professional development and support needs changed over time as teachers became more comfortable. Onsite support became less important than online support. Similarly, curriculum integration was difficult at first as teachers struggled to learn technical skills, but then became more important in making long term decisions about adoption.

Organizational factors also played key roles. Administrative support and availability of time to experiment and develop lessons or units and rubrics for assessment influenced adoption and integration, as did the sheer accessibility of equipment. Technology plans and support within the school and the larger community also served as significant facilitators.

Lessons Learned

It appears that the amount of each of the strategies listed in Table 1 influences student impact and project sustainability, as well. In general, technology planning tends to emphasize the strategies that are appropriate for the first two stages. However, as teachers mature into co-learners and reaffirmers, and as

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their students begin to develop technological expertise as well, new strategies must be added to the traditional type of professional development afforded by schools and districts.

Site-based teams or online learning networks must have a coherent, consistent vision that forges a strong connection between technology training, curriculum integration, and student performance assessment. Additionally, there must be a visible and valued incentive system in place for the project to go to scale (Elmore 1996). Although it is not necessary for the principal to be a technology leader, it is essential that his/her support be visible, that it represent a mandate for professional development in instructional technology, and that it be backed up with resources and organizational arrangements to provide sufficient time for training, practice, and authentic assessment of student products and performances.

The most important lesson to remember is this: in large scale instructional technology programs, one must consider the total context of learning activities, including all people in the community (teachers, students, resident experts, administrators, and involved parents) who are using rapidly evolving technological tools to accomplish their intended purposes. It is through community participation, not simply through individual agency or perceptions, that the total identity of the system is shaped and sustained.

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